WESTERN SPRUCE BUDWORM

USDA - FOREST SERVICE

INTERMOUNTAIN
FOREST AND RANGE
EXPERIMENT STATION

Bowles
Metcalf.

WHAT IS IT?
WHAT DOES IT DO?

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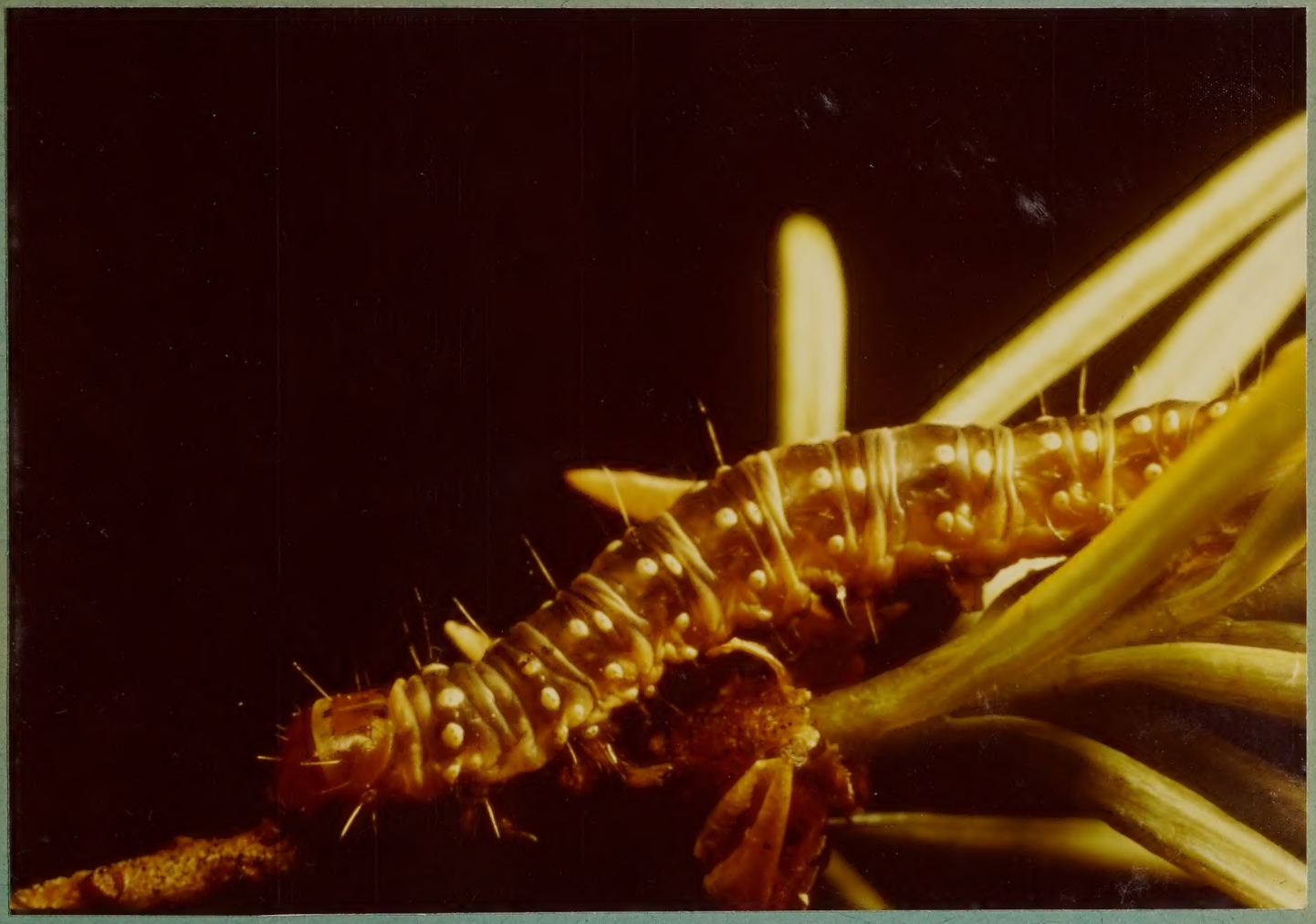

Mature larva of the western spruce budworm

The western spruce budworm is one of the most destructive forest pests in the northern Rocky Mountains.

For the past 25 years it has persistently defoliated and killed trees over 4 to 5 million acres, mainly in western Montana and northern Idaho.

The western spruce budworm is a typical defoliator. In the period of one year the insect evolves through four life stages--adult, egg, larva and pupa or resting stage.

The adult budworm is a buff-orange-colored moth (or miller). Adult moths live for only a few days, and do not feed. Their sole function is to reproduce. Shortly after the male fertilizes the female and she lays eggs, both die. The moth shown at the right is about 2 times actual size.

In late summer, the larvae, about one millimeter long, hatch from the eggs. At this time the larvae do not feed. The larvae and the Douglas-fir needle below are about 8 times natural size.

Spruce budworm hatchlings spend the next 8 to 10 months in a dormant (or inactive) state on the host tree.

As the weather warms, in late spring, larvae emerge from their overwintering sites and begin searching for food. In dispersing, they often drop on silken threads.

Larvae bore into the yet unexpanded buds and begin feeding on the tender, succulent, but undeveloped needles inside.

As the buds expand and the needles develop, young larvae grow until by late June or early July they have matured, and are now about one inch long. Larva at left is 3 times actual size.

During this period, the developing caterpillars have been voraciously stripping the new foliage from the shoots, over the entire tree.

At the end of the larval feeding period, a typical shoot looks like this: All new needles have been eaten and the buds are set--ready for development the following spring, and to provide food for yet another generation of western spruce budworm.

After several years of successive defoliation, young Douglas-fir stands, such as this one on the Deerlodge National Forest, begin to look brownish-grayish, as more and more shoots are stripped of needles and some top killing becomes evident.

Continued budworm feeding kills more and more of the tree until in some young stands, a few dead trees become evident, interspersed with those already heavily defoliated or top-killed.

These trees are growing near the Gallatin National Forest - Yellowstone National Park boundary.

As outbreaks progress, on some sites more and more young trees are killed. Often dead trees are interspersed with trees that are less severely defoliated, or with trees on which the larvae do not feed...

(Whites Gulch, Helena National Forest).

In exceptional cases, entire hillsides of young trees are killed...

(Yankee Jim Canyon on the Gallatin National Forest).

Such heavy mortality usually occurs on hot dry south slopes where defoliation impact is coupled with an already harsh environment for the trees.

In most cases dominant trees in the stand suffer some defoliation and top killing, but are not killed outright...

...but in some cases, older and merchantable stands suffer exceptionally heavy defoliation and some trees are killed.

Sometimes, larger trees are heavily defoliated and often lose all or part of their crowns, but in a desperate effort to survive begin to produce foliage and limbs throughout the length of the tree.

These trees growing along Brackett Creek on the Gallatin National Forest remain alive and green, even though they are not "putting on much wood".

Although in western Montana the succulent new needles of Douglas-fir trees are the principal food of western spruce budworm larvae, the larvae do have other feeding habits and on other species of trees.

For example, budworm larvae also feed on the female cones of several species of trees--a feeding behavior that has resulted in serious deficiencies in the amount of seed that foresters have been able to collect for forest regeneration programs.

Here are two larch cones that have been eaten by spruce budworm larvae.

The cone on the right has had its entire left side eaten away including part of the "backbone" of the cone...

...while this cone has been so badly eaten that it is literally hanging together by threads. Attached to the upper part of the cone is a vacated pupal case from which an adult moth has emerged.

On western larch, larvae not only feed on the newly developing needles, as shown here, similar to the feeding on Douglas-fir, but...

...in young larch trees, larvae also feed on the newly developing shoot, usually partially or completely severing it.

Though not severed by feeding larvae, the leader of this young larch tree will no doubt be broken off by wind or snow.

A western spruce budworm larva has severed the terminal of this young larch tree, resulting in three or more lateral shoots competing for the terminal position.

Successive killing of the leaders of these young trees results in stooled and multiple-topped trees, such as the young larch shown on the opposite page, growing in a regenerated clearcut on the Lolo National Forest.

Western larch - along with Douglas-fir - is one of the most commercially valuable trees in western Montana, and...

...scientists at the Forestry Sciences Laboratory in Missoula have found that this type of damage by western spruce budworm larvae to young western larch trees not only results in bushy-topped trees...

...but is responsible for a net height growth reduction of 25 to 30 percent, thus jeopardizing two economically desirable characteristics of young larch--rapid juvenile height growth and straight boles.

WHAT REGULATES IT?

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Many natural factors help to keep western spruce budworm populations at low levels. Many species of insects are known to be predators or parasites of the budworm.

Here the white larva of a fly has just emerged from a pupa (with the emergence hole) while a healthy pupa (above) is ready to produce a budworm moth.

Spiders feed heavily on spruce budworm larvae and occasionally on moths.

Here, a small spider has just captured a budworm moth and is paralyzing it with its venom, prior to feeding on it.

Unfavorable weather often helps to keep populations of the western spruce budworm at low levels.

In mid-June of 1969, a killing frost hit parts of western Montana in the upper Clark Fork, Blackfoot, and Clearwater River drainages.

All of the new shoots on this young fir were killed by the frost--and later hung red and lifeless.

The new needles and shoots of this young larch tree were also killed by the frost.

Besides killing the new needles and shoots, the primary source of food for budworm larvae on these young trees, the frost also killed the larvae. Scientists at the Forestry Sciences Laboratory in Missoula determined that the frost killed more than 90 percent of the budworm larvae that were feeding at the time.

In spite of natural enemies and adverse weather, spruce budworm numbers have remained high in western Montana for the past 25 years, and larvae continue to defoliate trees, such as these growing on the Gallatin Forest.

WHAT HAVE WE DONE?

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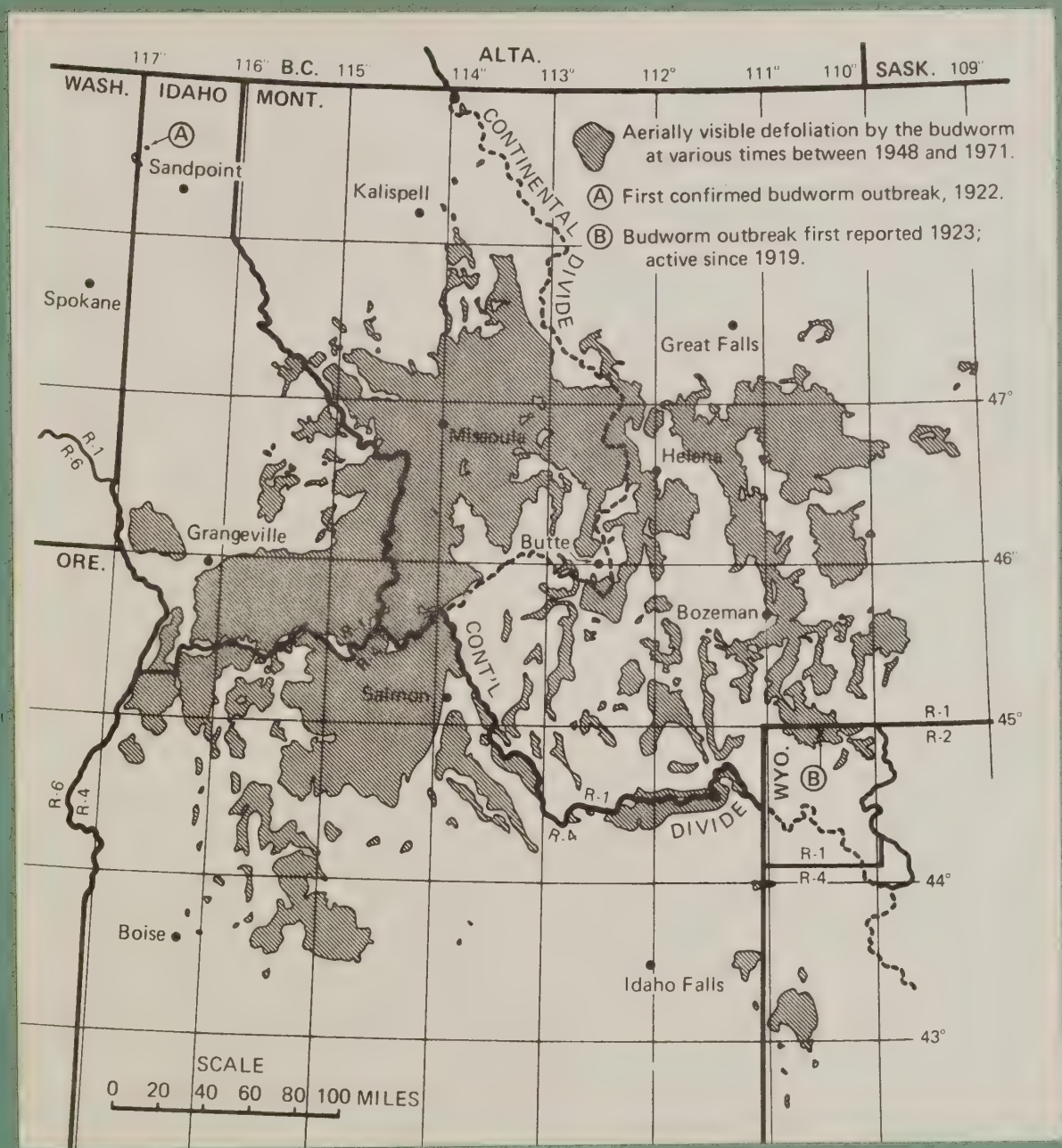
Between 1948 and 1971 the cumulative acreage of host forests in the northern Rocky Mountains defoliated by the western spruce budworm was in excess of 10 million acres.



The map shows that this damage was, and still is, spread over three states:

	million acres
Montana	8
northern Idaho	2
southern Idaho & Wyoming	5

In the early 1950's, resource managers in the northern Rockies decided that something had to be done to suppress western spruce budworm populations and minimize the impact to the forest.

They decided that the only course of action, and the only alternative available to them, was to treat the forests with insecticides.

A converted C-47 plane sprays DDT on western spruce budworm-infested trees on the Helena National Forest in 1956.

Resource managers continued to use chemicals against the budworm into the 1960's and to a lesser extent into the 1970's.

Between 1952 and 1976 a total of 6,226,460 acres of northern Rocky Mountain forests were treated with nearly as many gallons of insecticides--most of which was DDT.

During this 24-year period:

...3,277,130 acres were treated in Mont ana

...2,949,330 acres were treated in Idaho

During the 1960's, Forest Service scientists and others began...

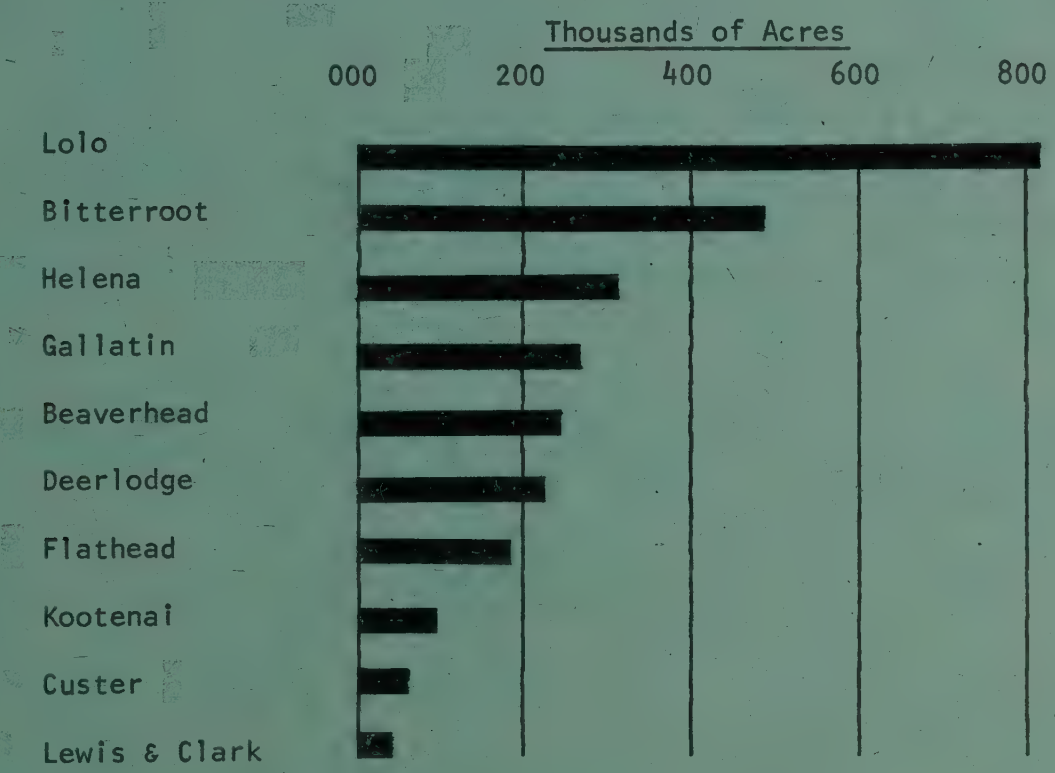
--testing newer less persistent chemicals to replace DDT,

-- developing more effective methods of applying them.

Although insecticide treatments provided some temporary respite for the infested forests, the course of the western spruce budworm outbreak has been essentially unaltered and the budworm infestations continue unabated.

THE SITUATION IN 1976

In 1976, in Montana alone, spruce budworm outbreaks covered 2,496,274 acres on ten National Forests as follows:



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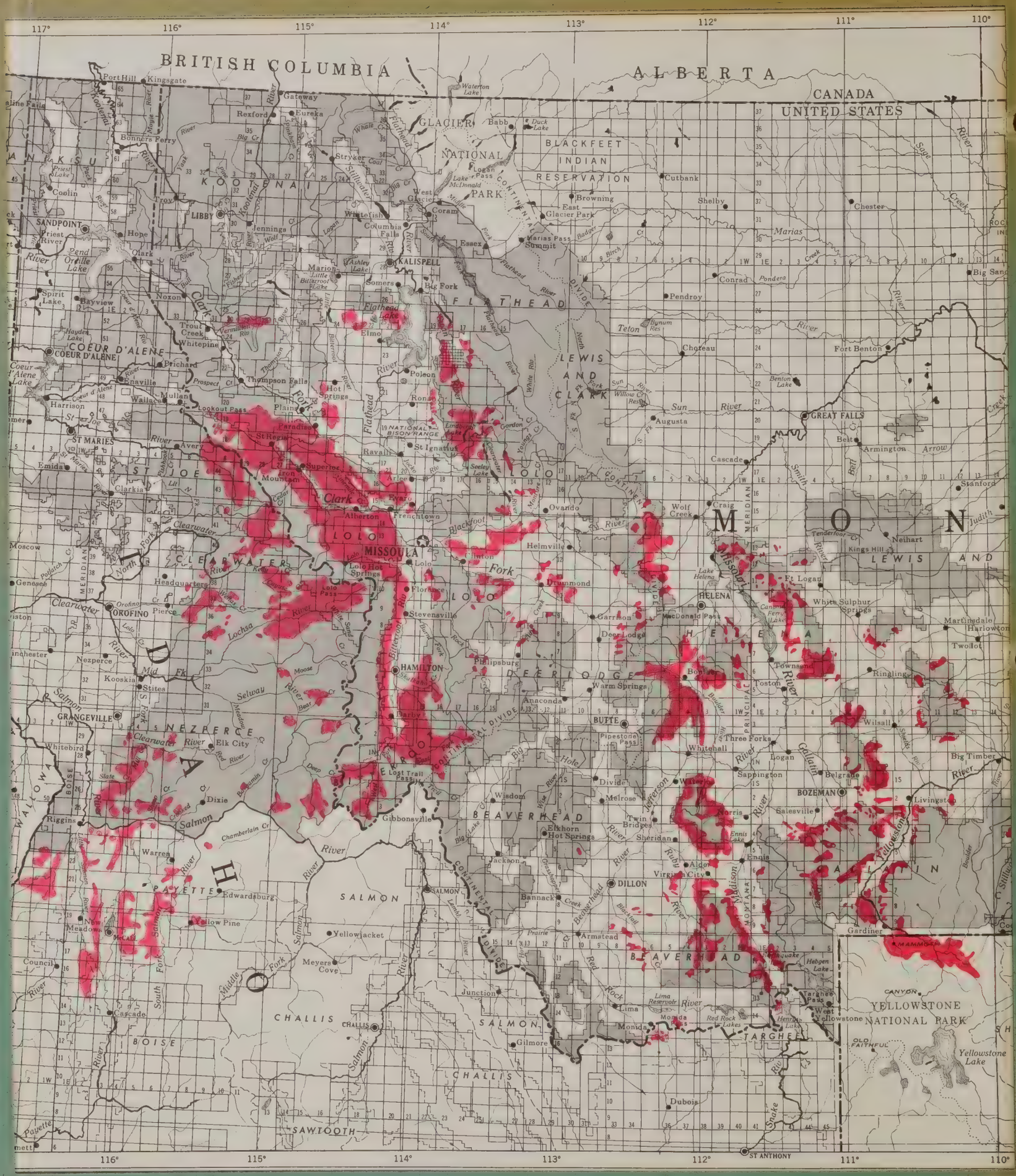

...for a better perspective, the red portions of the map show forests in Montana, Idaho and Wyoming infested with the western spruce budworm in 1976.

WHAT CAN WE DO?

WHAT CAN WE DO?

Resource managers recognize that:

- treating infested forests with pesticides is only a temporary alternative, a decision for today.
- the effects of pesticides are usually short-lived.
- there is no indication that the budworm will not be with us tomorrow.

So ... what is a long-term solution to the spruce budworm problem--a solution for tomorrow?

In 1975, a team of 12 scientists prepared a comprehensive proposal for a nationwide program of research and development on the spruce budworm. They identified five general areas where information is fragmentary or data are insufficient:

1) Accurate and reliable means to predict population levels.
2) Effects of the budworm on trees, stands, and plant communities.
3) Strategies to manage the budworm through biological, silvicultural or chemical means.
4) Impacts on related forest resources and values.
5) An economic framework for all management alternatives.

Resource managers in the northern Rocky Mountains are particularly interested in how forests can be managed to ameliorate the impacts of the budworm on cone and seed production, residual stands, and newly regenerating forests.

A spruce budworm research and development program as proposed will not only provide resource managers with the type of information they need for long-term budworm management, but will also help them to determine a tolerable level of co-existence between the forests and the western spruce budworm.